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Magnetic Resonance Imaging Report of Findings and Recommendations

Imaging Advisory Committee

January 2001

Introduction

The Imaging Advisory Committee (IAC) was formally established by Ministerial Order on October 21, 1999. The IAC is chaired by the Deputy Minister of Health and Wellness and consists of representatives from Alberta Health and Wellness, the Alberta Medical Association, the Alberta Society of Radiologists and the regional health authorities. The IAC's mandate is to develop a systems view of imaging which encompasses all modalities, provide a focus for collaboration on the strategic development of diagnostic imaging services, and provide overall guidance and direction to the Minister of Health and Wellness and stakeholders to ensure appropriate access to diagnostic imaging services. On April 14, 2000, the former Minister announced that he had requested the IAC "to develop a comprehensive long term strategy for the provision of MRI services within a responsible fiscal framework" and to report (MRI Report) its findings and recommendations by the end of October 2000.

The purpose of this report is to outline a strategy for the future of Magnetic Resonance Imaging (MRI) in Alberta. While MRI has been identified by the IAC as a priority for government, additional studies regarding demand/capacity will be prepared and form part of a report on all imaging modalities including computed tomography, nuclear medicine, positron emission tomography, ultrasound and radiographic modalities. This will help provide a strategic framework for understanding the needs, demands and future options for delivering effective imaging services for all Albertans.

The future for MRI in Alberta is optimistic. However, providing reasonable access to MRI will challenge government, physicians and health authority leadership. While establishing access to MRI technology is a priority for all stakeholders it is not as simple as setting up capital projects and funding initiatives. The acquisition of technology is wrapped up in a myriad of issues including the ability to support the technology from a technical and physician manpower perspective and determining "best test first" for MRI and other modalities. Striking the balance between initiatives that create optimal staffing to support technology acquisitions with access to needed care will be required. To be successful, efforts designed to investigate new staffing options, new physician recruitment and retention programs as well as dedicated MRI training will be required. Setting reasonable expectations with the public and referring physicians will be required as efforts to increase capacity are implemented.

This report not only provides recommendations regarding the future demand/capacity for MRI, but it also provides a model framework for forecasting demand for services over time. Efforts in the future must include appraisal of evolutions in the standard of care, "best test first" for MRI and anticipated changes in utilization rates so impacts can be modeled and

understood. By taking into account the future evidence and other relevant considerations, Alberta will be able to model and predict future demand/capacity as a strategic planning priority.

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Imaging Advisory Committee

Recommendations

1. Appropriate access to MRI services should become a strategic priority for Alberta.
2. Pending the completion of research to determine the appropriate scan rate for MRI in Alberta, the scan rate should be increased to a minimum of 24 scans per 1,000 population in 2001 recognizing that the Canadian Association of Radiologists (CAR) recommends a scan rate of 37.6 scans per 1000 for 2001.
3. Access to MRI services should be managed by uniform, province-wide standards that include definitions of urgency categories, wait times and imaging appropriateness criteria.
4. Imaging appropriateness criteria should be established for a pre-determined group of conditions and guidelines and policies respecting this criteria should be widely published and integrated into Radiology Information Systems (RIS) ordering processes.
5. Radiology Information Systems (RIS) with imaging ordering support and Picture Archival and Communications Systems (PACS) should be utilized to support MRI expansion in Alberta.
6. Patient teaching and education tools should be developed expressly around MRI and its clinical appropriateness to set reasonable expectations for demand based on medical evidence.
7. A comprehensive physician and technologist manpower plan should be developed to match the addition of new equipment capacity with physician and technologist resources.

Imaging Advisory Committee

MRI Findings

A. Report Focus

The focus of this report is to articulate how best to meet the MRI needs of Albertans.

Wait time and access to technology should be based on the best clinical evidence matched to the appropriate equipment capacity. While a case can be made that no wait time is the best wait time standard, this is simply unreasonable given the constraints of capital, operating costs and medical manpower availability required. The balance between the appropriate demand and capacity is tenuous given the assumptions that need to be made on what is thought to be medically necessary versus what is the "best test first".

Instead of attempting to argue the differences and nuances between what is thought to be medically necessary versus the "best test first", the IAC proposes an approach that initially models capacity and demand using agreed upon use rates which will then be modified through imaging appropriateness criteria. It is expected that the appropriateness criteria or "best test first" criteria will provide the necessary detail to understand the use of MRI as it relates to disease and conditions. The use rates for the year 2001 and prospective use rates for 2006 have been developed through blending the use rates of other industrialized countries with current Alberta capacity. This will provide the baseline to estimate the demand for MRI including the number of MRI's required, the distribution of MRI's within Alberta and the physician and technical staffing manpower to operate them.

B. Objectives

The objectives of this report are summarized as follows:

1. To profile the current status of MRI technology and its future application.
2. To develop an understanding of current and future targets for utilization in Canada and other industrialized nations around the world.
3. To identify the practice changes and the future state of technology expected to impact MRI usage over the next 5 years.
4. To establish an appropriate scan rate per 1,000 population for base year 2001 and forecast a future scan rate per 1,000 population in 2006 based on future utilization estimates.

5. To develop recommendations to optimize the MRI process through examination of best practice.
6. To determine a demand/capacity model for MRI using an IAC approved use rate for the year 2001 and prospective use rates for 2006.
7. To develop a set of recommendations with supporting documentation or "findings" to set a strategic platform for investment and implementation.

C. What Is MRI

Magnetic Resonance Imaging (MRI) is a diagnostic test that provides high-resolution pictures of the structure of any organ or area of the body. A MRI machine creates a magnetic field, then sends radio waves into the body and measures the response of its cells. From these responses, a computer is able to create a three-dimensional picture of the inside of the body. MRI can be used to identify tumors, strokes, degenerative diseases, inflammation, infection, and other abnormalities in organs and other soft tissue of the body.

D. Trends in the Evolution and Use of this Technology

Improvements in magnet technology designed to increase field strength and the quality of images is the new frontier for MRI technology. Older MRI units are gradually being replaced by new 1.5 Tesla MRI technology that provides the foundation for testing requiring high strength magnets and gradient subsystems. The application of MRI for stroke investigation and MRA (magnetic resonance angiography) for evaluating intracranial aneurysms and vascular occlusive disease will replace more costly and invasive procedures such as traditional angiography. Cardiac magnetic resonance imaging is also expected to grow given techniques associated with diagnosing cardiac anatomy, functioning and visualization in a single test. Non-invasive testing will make a significant impact on health care costs particularly in high-end surgical product lines such as neurosciences, orthopaedics, vascular surgery and cardiology.

Other future uses for MRI resulting from technological innovation will come in the areas of interventional MRI designed to provide screening and image guided breast biopsy for women with breast cancer requiring breast conserving surgery and follow up. Long term uses for MRI at the forefront include echoplanar imaging (EPI), an extremely fast form of imaging that currently creates too poor an image for clinical use, but with further refinements will allow early detection of cerebral vascular accident (CVA). Other various methods of therapeutic tumor ablation may be possible in the future due to the sensitivity of MRI imaging to temperature and temperature change. Methods such as hyperthermia and cryosurgery will use MRI capabilities extensively.

Developments in intraoperative MRI will also allow neurosurgeons to assess progress and to alter surgical plans real time in the operating room setting during surgery. Other uses such as improving the efficacy of frameless stereotaxy that provides surgical guidance based on the images acquired preoperatively will improve the ability to perform safe and effective cyto-reductive brain tumor surgery. It has been indicated by experts that stereotaxy is even more powerful when used in conjunction with intraoperative imaging.

Other improvements will address patient comfort and convenience issues. Older closed MRI units are not patient friendly and many patients report discomfort from the noise and "coffin" like design. Future technological improvements, from short bore to open MRI technology that will serve to satisfy radiologists on image quality of open MRI versus studies performed on closed high field MRI systems, will shift the balance to patient comfort.

These factors, in addition to the fact that MRIs are five to ten times more accurate than other imaging modalities for a range of appropriate conditions will result in continued demand for this technology. In addition, the aging of the population has been particularly important in contributing to increased demand for diagnostic testing especially in the area of orthopaedics.

Recognizing the ability of patients to push for "patient friendly" options, MRI vendors are developing direct to consumer advertising with messages that encourage patients to ask their hospital whether they have the latest in MRI technology. It is estimated that some MRI vendors spent close to $1 million in radiology equipment advertising during the Sydney Olympics to cultivate patient knowledge of new imaging technologies such as MRI, open MRI and digital mammography. GE Medical Systems, Siemens and others who track imaging equipment utilization report the following utilization increases for MRI - 92-95 9% per year, 96-99 15% per year and forecast 17% for 00-03. To assist in managing public expectations regarding access, the appropriateness of one imaging modality versus another as the "best test first" will need to be developed and communicated.

Conclusions:

1. Future advances in MRI field strength, imaging speed and image quality will expand the use of MRI for clinical indications especially in the neurosciences, orthopedics, vascular surgery and cardiology.
2. Technology vendors will also address increased demand by improving technologies for both clinical use and patient ease of use. Developments such as lower cost 1.5 Tesla units, specialty based MRI magnets, and open MRI will be future innovations.

3. MRI will move from "something special" to a necessary tool in diagnostic imaging. The demand for MRI will continue to grow. MRI utilization rates are forecasted to grow at a rate of approximately 15% per year over the next three years.
4. Appropriateness criteria based on the best clinical evidence will be key to setting expectations with the public and referring physicians.

E. MRI Utilization Around the World

A study completed by The Fraser Institute entitled "The Availability of Medical Technology in Canada: An International Comparative Study" published in August 1999 identified that in the early 1980's Canada had a high stock of MRIs relative to other developed nations. However, since that time Canada's position had slipped such that in 1997 18 countries had more MRIs per capita than Canada. In France, the increase of MRI equipment per capita has occurred more rapidly in private hospitals than in public hospitals. In the United States, rapid diffusion of MRIs occurred in freestanding clinics not connected to hospitals. According to the1997 data collected and summarized in Table 1, with 1.7 MRIs per million persons Canada was well below the OECD average of 3.9 per million. The lack of MRIs in Canada, implied by the same Fraser Institute study, is delaying the diagnosis of many conditions and causing some patients to undergo surgery without a properly defined diagnosis. Moreover, in recent years there has been growing evidence of a decline in the quality and quantity of health care available to Canadians. The Fraser Institute further states that efforts to define the nature and cause of these problems have pointed to the possibility that one contributing factor is the lack of access to high technology equipment and procedures. Table 1 demonstrates that Canada ranked toward the lower end of the distribution in the number of MRI scanners per million population.

Table 1: World Wide Ranking - #MRI Scanners Per Million

Rank	Country	#MRI Scanners per 1,000,000 Pop.	Health Spending as a % of GDP
1	Japan (1996)	18.8	7.2
2	United States (1995)	16.0	14.1
3	Austria (1997)	8.4	7.9
4	Switzerland (1993)	7.4	9.4
5	Sweden (1995)	6.8	8.5
6	Germany (1996)	5.7	10.5
7	Korea (1997)	5.1	4.0
8	Netherlands (1995)	3.9	8.8
9	Italy (1995)	3.5	7.7

10	United Kingdom (1995)	3.4	6.9
11	Belgium (1995)	3.3	7.9
12	Spain (1996)	3.2	7.4
13	Australia	2.9	8.4
14	Portugal	2.8	8.3
15	New Zealand	2.7	7.6
16	Denmark	2.5	8.2
17	Finland	2.4	8.0
18	France	2.4	9.9
19	*Canada (1997)*	*1.7*	*9.3*
20	Hungary	1.4	6.7
21	Czech Republic	1.3	7.0

Source: OECD Health Data 1998. Paris: OECD.
Note: The OECD has issued a year 2000 update to the worldwide rankings. This new information has not been added to this table for two reasons: (1) Canada's position as #19 did not change; and (2) the information provided in the update is incomplete.

In the United States in 1997, there were 4,000 MRIs of which 900 were located in freestanding imaging centers, 700 located in mobile facilities and 2,400 located in hospital settings. While statistics prepared by the American Healthcare Radiology Administrators suggest that approximately one MRI unit is required for every 125,000 people, U.S. statistics show the actual ratio is one to 43,000. Interestingly enough, these high utilization rates exist despite efforts to manage utilization rates. Table 2 outlines the scan rates per thousand population based on 2001 to 2006 forecasts.

Table 2: Scan Rates Per Thousand

Country	2001 Scans/1000	2006 Scans/1000
United States <65	53	88
>65	110	187
Germany	39	62
Japan	29	47
France	20	32
Italy	17	28
UK	11	18

Note: 2001 rates were developed from GE Medical Systems forecasts. Forecasted 2006 rates were based on a very conservative growth rate of 10% per annum.

Conclusions:

1. The utilization of MRI in Canada is well below the OECD average.
2. The expanded use of MRI in Canada may well improve the overall health status of Canadians and if appropriately utilized, reduce overall health care expenditures.
3. If Alberta were to raise its scan rate target to 24 scans per 1,000 population, this target would represent median performance when compared to other industrialized countries.

F. MRI Utilization in Canada

Table 3 outlines the provincial approaches to MRI in all Canadian provinces and territories including the number of public MRIs and how MRI is funded.

Table 3: Provincial MRI Strategies

Province	#MRIs	Funding
British Columbia	7 Public	Ministry provides Global Fund to cover all costs including Radiologist fees.
Alberta	6 Public 7th at Alberta Cancer Board	Regional Global Budget with Radiologists contracted through the Region.
Saskatchewan	3 Public	Regional Global Budget with Radiologists contracted through the District.
Manitoba	3 Public	Regional Programs with Radiologists billing fee for service.
Ontario	31 Public	Global Hospital Budgets with Radiologists paid fee for service and through hospital budgets.
Quebec	19 Public	Facility budgets with Radiologists paid fee for service.
PEI	0	Provincial Program with Radiologists paid through interprovincial reciprocal payments.
Nova Scotia	2 Public	Provincial Program with Radiologists paid fee for service.
New Brunswick	3 Public	Provincial Program with Radiologists paid fee for service.
Newfoundland	1 Public	Provincial Program with Radiologists paid fee for service.
NWT	0	Territorial program with Radiologist paid through interprovincial reciprocal payments.
Nunavut	0	Territorial program with Radiologist paid through interprovincial reciprocal payments.
Yukon	0	Territorial program with Radiologist paid through interprovincial reciprocal payments.

Source: Data collected by Alberta Health and Wellness from provincial contacts. Data from Quebec not verified.

The Canadian Association of Radiologists (CAR) recommends a scan rate of 37.6 scans per 1,000 population in 2001. Information provided by provincial contacts indicates a scan rate across all provinces per 1,000 population ranging from 12 to 23 for the year 2000. If scan per 1,000 rates increase to the rates recommended by CAR, this will represent a significant increase in capacity as well as demand for radiologists and technologist resources to support the technology.

Conclusions:

1. The management of MRI varies from province to province. Most arrangements are either managed as either a provincial or regional program with radiologists contracted for professional services on a fee for service basis. Only Quebec provides a framework created on a facility based budget.

G. Managing MRI Utilization

As part of the MRI demand capacity initiative, a complementary initiative was undertaken by the IAC to assess the impact of the appropriateness of one imaging modality versus another in the diagnosis of specific diseases and conditions. The intention of assessing the appropriateness of one imaging modality versus another was to determine "best test first" – the appropriate imaging study leading to the precise diagnosis if performed first. Once assessed, this information could be used to fine-tune the difference from a progression of tests starting from the most inappropriate to the most appropriate resulting in the best clinical outcomes for the referring physician and patient.

In order to complete this work, the IAC agreed to use the appropriateness criteria developed by the American College of Radiology as a starting point for an Alberta based utilization management education program. Teams of radiologists were engaged in Edmonton and Calgary to review appropriateness criteria for musculoskeletal health, oncology, body systems, pediatrics and neurosciences. In total, over 400 conditions and variants will be reviewed. Once completed, each radiologist team will exchange their findings with specialty physicians representing each team in Edmonton and Calgary to review the appropriateness of their conclusions and to identify potential areas of contention. Over the course of this study, over 50 physicians will be engaged across the province in completing the review and validating the results.

The outcome of completing appropriateness criteria will have a tremendous impact on the final targets for MRI demand and capacity. While the initial findings of this report will rely on forecasting demand targets based on blended use rates gathered from benchmarking, the addition of appropriateness criteria will provide the data to fine-tune demand down to a specific disease grouping. Appropriateness criteria will also provide the evidence to track specific volume impacts for MRI as a substitute technology for another imaging modality as technology evolves or as the standard of care changes. This represents a substantial ability to estimate utilization and to track changes in utilization from a disease grouping or a condition perspective.

From a forecasting perspective, the ability to detail demand down to a specific condition will allow for the provision of specific parameters that can be added to the model so that volume impacts by region can be assessed retrospectively and prospectively. It is further suggested that the models developed as the basis for this report be updated on an annual basis with updated use rate data and all revisions impacting demand based on changes to the appropriateness criteria.

The development, maintenance and management of imaging appropriateness criteria should become an ongoing responsibility. Resources should be allocated to support ongoing revision of the criteria and developing the volume estimates to revise demand capacity models for MRI and other imaging modalities as they evolve over time. The development of appropriateness criteria will also require that guidelines and policies be published and available for review by referring physicians and radiologists. While it would be a daunting task to educate each and every physician on all the appropriateness criteria for MRI, the best opportunity to impact utilization management is to link MRI appropriateness criteria into the radiology information system order entry processes. Establishing a linkage that validates "best test first" with the appropriate resources to support physician consultations and referral processes will enable the management of utilization as well as expectations.

Conclusions:

1. The development and use of appropriateness criteria is a key input to managing the utilization of MRI and will have a significant impact on the proper use of imaging studies for a predetermined set of diseases and conditions.
2. Guidelines and policies should be published to support the proper use of imaging studies for a pre-determined set of diseases or conditions as best test first.

3. The utilization of imaging appropriateness criteria should be evidence based and timely. Input is required from Alberta based physicians to ensure the best test first reflects clinical practice and standards.
4. Appropriateness criteria should be integrated into ordering processes to ensure they are used to manage utilization of imaging resources. Integration of appropriateness criteria into radiology information system ordering processes should be supported with physician consultation services to augment the care process and to manage expectations. Information system development funding will be required to achieve this integration.
5. Patient education and teaching tools should be developed around the appropriate use of MRI as "best test first" in order to set reasonable demand based on medical evidence.
6. Imaging appropriateness criteria should be used as a core input to establish the volume impacts for MRI as new standards of care are defined that identify MRI as the best test first. This data will augment the model and will serve to validate the use rate data as a secondary source of insight.

H. Manpower Challenges

The future demand for MRI capacity is not just a technology acquisition challenge. Additional MRI capacity will require technologists and radiologists to both operate the equipment and interpret the scans. Unfortunately, it is well recognized that there is a shortage of radiologists and technical staff worldwide. Innovative solutions to staffing, training, recruitment and retention will be required to deal with the manpower shortages.

The recently released Physician Resource Planning Committee Report has acknowledged a potential need for additional radiologists who are in short supply across Canada. In addition, technology advances and new applications will further complicate this shortage as radiologists will need to serve as "knowledge" centers for the physician community by aiding in complicated diagnoses and treatment planning, particularly in musculoskeletal, cardiac, neurology/neurosurgery, vascular and oncology specialties. Solutions will need to be found to leverage radiologist manpower possibly through the use of tools such as PACS and teleradiology.

Conclusions:

1. Alberta will be forced to compete for scarce physician and technologist manpower as provincial programs expand given nationwide manpower shortages and increases in demand for MRI services.

2. New solutions and innovative strategies need to be pursued to develop staffing models to mitigate shortages in manpower. Efforts will be required to retain all MRI technology graduates if future demand for manpower is to be met.
3. Each and every capital acquisition designed to expand access to MRI should be investigated from a technology and manpower perspective. Impact models should be developed to identify the balance required between utilization targets with the appropriate complement of resources to support the investment in new technology.
4. Impact modeling should become a formal process. Balancing capital acquisitions with the demand for manpower is necessary to setting, delivering and managing expectations with the public, referring physicians and other stakeholders.

I. MRI Costs

MRI is not an inexpensive imaging modality. While innovations in MRI technology that allow for shorter procedure time and an increased number of scans per day have been advanced, the relative cost for MRI versus other imaging modalities is still high. While it could be argued that the appropriate higher cost imaging study leading to the precise diagnosis if first performed is generally cost saving, there are few documented cost effectiveness and outcome studies regarding the value of MR imaging versus other imaging modalities.

In order to develop an estimate of the cost of MRI, analyses were performed to calculate the variable cost per scan based on the acquisition of new technology at varying volumes per year using data provided by the leading equipment vendors. Base operating costs per scan are estimated to be between $236.53 and $263.59 dollars per scan. As part of the cost analysis, volumes of 3500, 5000, 7000 and 10,000 scans per year were analyzed to determine what the variable cost per scan would be based on varying use rate scenarios. Professional fees were based upon existing negotiated fees. Supply costs were calculated using film costs, miscellaneous supply costs associated with MRI and costs for contrast media based on the percentage number of cases requiring the use of contrast media. Contract maintenance for ongoing service costs were generated using rates supplied by GE for a 5-year maintenance schedule on a 1.5 Tesla closed MRI. Staffing costs were based upon current salaries and the FTEs required to support volumes in the various scenarios of 3500, 5000, 7000 and 10,000 scans per year. Adjustments included shift differentials, certification adjustments and benefits at 15%. The total base cost per scan at the varying rates are identified in Table 4.

Table 4: Scan Rates Per Year & Estimated Base Costs Per Scan

Scans Per Year Per MRI	Professional Fees	Supplies	Cont. Maint.	Staffing	Total Operating Costs per Scan
3,500	$117.00	$60.10	$36.71	$49.78	$263.59
5000	$117.00	$60.10	$26.11	$46.31	$249.52
7,000	$117.00	$60.10	$18.66	$48.70	$244.46
10,000	$117.00	$60.10	$14.50	$44.93	$236.53

Notes:

- Film $12.50 for 8 sheets, miscellaneous $8.00 (includes supplies IV sets, linens), contrast media $120 per dose @ 33% of scans.
- Equipment maintenance for 1.5 is $125,000-145,000 per year.
- Average technical wage of $26.00/hr + $1.50 after 3 pm. Includes+$1.10 weekends. Also includes reception wages.
- Benefits at 15%.

This amount does not include:

- Any overhead allocations for items such as facility costs and management.
- The capital cost of the MRI - estimated to be $2.4 million for a 1.5 Tesla closed MRI and $1.5 million for an open MRI.
- The cost of constructing a MRI facility estimated to be between $300,000.00 to $1,000,000.00 depending upon site and facility selected.
- The cost of leasing or purchasing a building.
- The costs of upgrades to prevent obsolescence at 10% - 12% of the purchase price per year i.e. a 1.5 should be budgeted for approximately $200,000.00 annually (the amount will vary annually but this is a good average).

Future cost containment strategies may be pursued that will result in lower total operating costs per scan through the use of Picture Archiving and Communication Systems (PACS). With advances being made in the large hospitals across Alberta in installing digital software to support filmless operations for most imaging modalities including MRI, savings in film and film management will be possible over time. Other benefits that will accrue to MRI include the display and archival of imaging studies that can be incorporated into a provincial wide network accessible by secured means.

Conclusions:

1. MRI is an expensive technology. Future efforts should be directed toward implementing cost-effectiveness and outcome studies that prove the value of the appropriate higher cost imaging study.
2. MRI facilities, resources and manpower should be managed as an asset. Closely managing volume with the appropriate resources can result in a lower operating cost per scan. MRI units should be managed as close as possible to full capacity to generate the most effective use of physician, technologist and other supply resources.
3. Innovative staffing models and tight supply cost management will be key in managing MRI as an asset.
4. PACS presents a significant advancement to improve access to images and a source of cost reduction in film and film management.

J. MRI Utilization in Alberta

Significant strategic decisions have been implemented by Alberta Health and Wellness to ensure that MRI services are more accessible to Albertans without any additional out of pocket expense to the patient. The emphasis has been placed on developing solutions that provide covered services through public funds while reducing long wait lists.

Both Calgary and Capital Regional Health Authorities have provided public MRI services to Albertans for a number of years. In the summer of 1999, Chinook Regional Health Authority also began offering MRI services in Lethbridge. 99/00 Scan volumes are reflected in Table 5.

Table 5: Alberta MRI Volumes

MRI Location	Volumes 99/00	Volumes 00/01 (First Quarter Only)
Lethbridge Regional Hospital Chinook Regional Health Authority	1660 (Quarters 2, 3 & 4)	727
University of Alberta Hospitals Royal Alexandra Hospital Capital Health Authority	15066	4340 (2250 additional scans for 00/01 via private contractor)
Foothills Medical Center Peter Lougheed Hospital Calgary Regional Health Authority	14953	4489 (4151 additional scans for 00/01 via private contractor)

David Thompson Regional Health Authority	0	705
Total Scans	31,679	Equates to an estimated 47,445 total scans in 00/01)

Calgary and Capital Regional Health Authorities will have the capacity to increase MRI scan volumes through the addition of three MRIs each in Calgary and Edmonton. The Calgary MRIs will be located at the Rockyview General Hospital, the Alberta Children's Hospital and the Foothills Medical Center will receive a second MRI. The Edmonton MRIs will be located at the Grey Nuns Hospital, the Misericordia Hospital and the University of Alberta Hospitals will receive a second MRI. In addition, MRI services have become available in Red Deer (David Thompson RHA) as of April 2000 and services will be initiated in Grande Prairie (Mistahia RHA) and Medicine Hat (Palliser RHA) in 2001. This will represent a growth in access from 31,679 scans in 1999/2000 to 73012 based on a minimum scan rate of 24 per 1,000 for Grande Prairie, Edmonton, Red Deer, Calgary, Lethbridge and Medicine Hat in 2001.

Privately owned MRIs under contract to RHAs are being utilized to reduce waits for patients. These contracts are for a set number of scans.

Conclusions:

1. New capacity in the form of capital investment in equipment will make it possible to significantly increase scan volumes in Alberta to a level nearing the median of other industrialized nations.
2. MRI will soon be available to all Albertans at sites closer to their communities.
3. The potential exists to utilize MRI capacity outside of the RHAs should the need to reduce wait lists be required.

K. Use Rate Modeling

A modeling methodology was developed to simulate the impacts of utilization rates on the regions using estimates for 2001 populations as well as forecasted 2006 population rates based on growth rate percentages. All the data were analyzed using a non-linear simulation model called STELLA, capable of simultaneously modeling use rates upon populations with the required technology and manpower resources. STELLA is a powerful tool that has been used to model other large non-linear systems such as

transportation systems, traffic and financial systems such as interest rates and the movement of the stock market.

Scan rates of 24, 30 and 36 per 1,000 population were used as scenarios for modeling purposes for 2001. These scan rates were used to determine what each site would be capable of and what the demand would be. Growth factors of 10% and 15% were used to estimate future volumes for 2006. These growth factors were used to give an indication of future demand based on both a conservative estimate of growth and anticipated growth.

Step One of the methodology involved developing an appropriate utilization rate for the Alberta population. Under these conditions, utilization models for planning purposes were based on the total Alberta population using various scan rates as depicted in Table 6 below.

Table 6: Model Assumptions – Population and Scan Rates 2001-2006

Region	2001 Pop.	2006 Pop.	# Scans in 2001 @ 24, 30 & 36 Scans/1000	# Scans @ 10% growth per annum in 2006 39, 48 & 58/1000	# Scans @ 15% growth per annum in 2006 48, 60 & 72/1000
1 Chinook	150,264	154,874	3606/4508/5409	6040/7433/8982	7433/9292/11150
2 Palliser	94,976	106,171	2279/2849/3419	4140/5096/6158	5096/6370/7644
3 Headwaters	77,968	89,313	1871/2339/2806	3483/4287/5180	4287/5359/6430
4 Calgary	979,551	1,136,356	23509/29386/35263	44318/54545/65909	54545/68181/81817
5 Region 5	55,983	61,028	1343/1679/2015	2380/2929/3540	2929/3662/4394
6 David Thompson	200,931	227,701	4822/6028/7233	8880/10929/13207	10929/13662/16394
7 East Central	107,344	115,699	2576/3220/3864	4512/5553/6710	5553/6942/8330
8 Westview	94,448	102,758	2266/2833/3400	4007/4932/5960	4932/6165/7398
9 Crossroads	41,265	44,935	990/1238/1485	1752/2156/2606	2156/2696/3235
10 Capital	831,925	870,410	19966/24958/29949	33946/41779/50484	41779/52225/62669
11 Aspen	84,017	87,572	2016/2521/3024	3415/4203/5079	4203/5254/6305
12 Lakeland	112,780	124,245	2706/3383/4060	4845/5963/7206	5963/7455/8945
13 Mistahia	95,104	105,914	2282/2853/3423	4131/5083/6143	5083/6355/7625

14 Peace	19,719	18,909	473/592/709	737/907/ 1097	907/1135/ 1361
15 Keeweetinok	29,784	31,584	714/894/ 1072	1232/1516/ 1832	1516/1895/ 2274
16 Northern Lights	43,665	51,370	1047/1310/ 1571	2003/2465/ 2979	2465/3082/ 3698
17 North West	21,652	26,112	519/650/779	1018/1253/ 1514	1253/1567/ 1880
Totals	**3,041,376**	**3,354,951**	**72985/ 91241/ 109481**	**130843/ 161029/ 194587**	**161029/ 201297/ 241549**

Note: Population forecasts derived from data available on the Alberta Health and Wellness web site.

The second step of the methodology involved creating a realistic population estimate including the migration of patients to specific centers. To accomplish this, the Alberta population was assigned to various scan sites based on travel distances, historic referral patterns and specialty physician expertise. This migration of patients was reviewed with the health authorities to ascertain reliability and validity. Table 7 identifies the percentage of patients served, the patient origin by residence for Grande Prairie (Mistahia), Edmonton (Capital), Red Deer (David Thompson), Calgary (Calgary), Lethbridge (Chinook) and Medicine Hat (Palliser) as the designated MRI centers.

Table 7: Population Migration – Anticipated Service Centers

Grande Prairie	Edmonton	Red Deer	Calgary	Lethbridge	Medicine Hat
90% Reg. 13	5% Reg. 6	90% Reg. 6	10% Reg. 1	90% Reg. 1	90% Reg. 2
50% Reg. 14	25% Reg. 7	50% Reg. 7	10% Reg. 2	10% Reg. 3	10% Reg. 5
25% Reg. 15	100% Reg. 8	10% Reg. 5	90% Reg. 3		5% Reg. 7
25% Reg. 17	90% Reg. 9	10% Reg. 9	100% Reg. 4		
	100% Reg. 10		80% Reg. 5		
	100% Reg. 11		5% Reg. 6		
	100% Reg. 12		20% Reg. 7		
	10% Reg. 13				
	50% Reg. 14				
	75% Reg. 15				
	100% Reg. 16				
	75% Reg. 17				

Note: Assumes all sites are fully operational in 2001. Also assumes that each "rural" region would need to access either Calgary or Edmonton for 10% of its scanner volume due to specialty or subspecialty consults.

The third step of the methodology involved creation of specific demand capacity models for MRI. As stated earlier, demand/capacity models were

then generated using a non-liner modeling software program called STELLA. The STELLA modeling system is particularly useful in simulating health care requirements because changes in demand are generally not linear in their cause and effect.

STELLA has the capability of simulating the variability in the "real world" using variations in constraints providing a more accurate view of demand based on real need. The key distinction between the linear and non-linear methodologies is that linear approaches use specific quantitative parameters that provide very accurate information leading to single solutions. Often these single solutions lose their accuracy and relevance rapidly over time as the factors identified change or disappear. In addition, these linear models end up as "wrong" because they cannot take into account all the variables, conditions and constraints inherent in complex processes such as forecasting demand for health services. In fact, it is rare in health care that one encounters situations that involve making decisions in a sequential manner with impacts presenting in a similarly sequential manner with all variables and conditions identified and understood. More often than not, the fluctuations inherent in availability of services, location of services, number of providers, hours of operation, the availability of staff and the length of the wait list, create a non-linear process in the demand for service. The use of non-linear modeling tools provides the capability to model and structure the impacts of such a dynamic process.

The basis of the STELLA non-linear technique views processes, systems, structures as a series of interconnected feedback loops consisting of decisions, resulting actions and new actions depending on options selected. Therefore, non-linear analysis provides the ability to predict probable effects depending on a set of decision rules or decision variables. As input to this modeling, the IAC made the following assumptions:

1. Waits were modeled at 24 hours for emergent, 30 calendar days for urgent and 90 calendar days for non-urgent.
2. 20% of scan volume was assumed to be emergent, 40% of scan volume was assumed to be urgent and 40% of scan volume was assumed to be non-urgent.
3. Access - emergent 7 days per week, urgent & non-urgent 5 days per week.
4. A shift is 8 hours.
5. Each MRI can operate a maximum of 16 hours per day plus on call emergencies. Productivity rates for modeling purposes were estimated at 1.8 scans per hour based on1.5 Tesla equipment.
6. Manpower assumptions:
    1. A qualified radiologist can read 20 MRIs in an 8 hour shift.
    2. Radiologists work 40 hours per week and take 6 weeks off per year.
    3. Technical staff work 40 hours per week and take 4 weeks off per year.

7. Three technical staffing options were considered:
    1. Option 1 – staff each MRI with two trained MRI technologists. The advantage of this option would be that the MRI would operate continuously through each 8-hour shift as staff breaks would be staggered.
    2. Option 2 – staff each MRI with a single trained MRI technician and an LPN or other licensed staff member capable of giving injections and providing other clinical needs. This option would cause each MRI to be shut down for 1+ hours per shift, but would reduce the number of MRI technologists required by 50% (scanner would shut down for breaks). The impact would be a loss of 2 scans per shift per scanner.
    3. Option 3 – Co-locate MRIs two per MRI facility. Staff with either all technologists or a combination of technologists and other licensed staff. Each facility could then be staffed by three staff members per MRI versus four.

L. Model Results

Using the methodology outlined above, the following scenarios have been developed for 2001 for Grande Prairie, Edmonton, Red Deer, Calgary, Lethbridge and Medicine Hat. Results are presented for 2001 using the scan rate per 1,000 of 24, 30 and 36. Model results for future scan rates per 1,000 based on 2006 using estimated growth factors have also been presented to identify the potential range of growth for MRI over the next five years. It is fully expected this model will be fine-tuned for revision to the scan rate per 1,000 as the appropriateness criteria is completed for best test first. The addition of appropriateness criteria will provide detailed insight into the actual application of MRI by specific condition and the potential for the substitution of MRI to another imaging modality and the impact of that change on the other modalities. This will be extremely useful in modeling the demand/capacity for other imaging modalities as MRI capabilities expand or as the literature demonstrates additional application for MRI as the best test first. Implications related to the number of MRIs and manpower requirements are presented for the minimum recommended rate of 24 scans per 1000 and for a rate that would maximize MRI utilization. Base operating costs were forecasted using the cost per scan at the 7,000 scan volumes detailed in Table 4.

Table 8: Grande Prairie Model Results 2001-2006

Year	**2001**			**2006**			**2006**		
Scan Rate/1000	**24**	**30**	**36**	**39**	**48**	**58**	**48**	**60**	**72**
Total Scans	2598	3249	3897	4648	5720	6913	5720	7152	8581
Average Scans Per Day	10	12	15	17	21	26	21	27	32
Maximum Scans	11	13	16	19	24	29	24	30	36
Max. Scan Hrs @ 1.8 Scans/Hr.	5.9	7.4	8.9	10.6	13.1	15.8	13.1	16.4	19.6
Minimum # MRI's	1	1	1	1	1	1	1	1	2
Shifts									
Weekdays	1	1	2	2	2	2	2	2	3
Weekends	1	1	1	1	1	1	1	1	1
Estimated Operating Costs @ $244.46 in $000's	635	794	952	1,136	1,398	1,689	1,398	1,748	2,097

MRI and manpower requirements at 24 scans/1000

- 1 MRI operating 4 - 6 hours per day M-F and on call on the weekend.
- Radiologists = .75 per day or 1 FTE (would require 2 trained MRI radiologists at a minimum).
- Technologists = 1 Tech & 1 LPN per day and on the weekend shift. 1.25 Technical FTEs and 1.25 LPN FTEs.

MRI and manpower requirements at 30 scans/1000

- 1 MRI operating 8 hours per day M-F and 1 shift on the weekend.
- Radiologists = .75 per day or 1 FTE (would require 2 trained MRI radiologists at a minimum).
- Technologists = 1 Tech & 1 LPN per day and add urgent and non-urgent volumes to a weekend shift when necessary. 1.25 Technical FTEs and 1.25 LPN FTEs.

Table 9: Edmonton Model Results 2001-2006

Year	**2001**			**2006**			**2006**		
Scan Rate/1000	**24**	**30**	**36**	**39**	**48**	**58**	**48**	**60**	**72**
Total Scans	31167	38965	46753	53834	66256	80064	66256	82826	99387
Average Scans Per Day	117	146	175	201	248	300	248	310	372
Maximum Scans	128	161	192	221	273	330	273	341	409
Max. Scan Hrs @ 1.8 Scans Per Hr	71.3	89.1	106.9	123.1	151.5	183.1	151.5	189.4	227.3
Minimum # MRI's	4	5	6	7	8	10	8	10	13
Shifts									
Weekdays	8	10	12	13	16	20	16	20	25
Weekends	2	2	2	2	3	3	3	3	4
Estimated Operating Costs @ $244.46 in $000's	7,619	9,525	11,429	13,160	16,196	19,572	16,196	20,247	24,296

MRI and manpower requirements at 24 scans/1000

- 5 MRI's 3 of which operate 16 hours per day and 2 operate 8 hours per day weekdays. 2 MRI's operate 8 hours per day on weekends plus on call.
- Radiologists = 6.5 per day or 7.5 FTEs.
- Technologists = 16 Techs per day weekdays and 6 Techs weekends (to cover call) = 19.5 Technical FTEs.

MRI and manpower requirements at 30 scans/1000

- 5 MRIs 5 of which operate 16 hours per day weekdays and 2 MRIs operate 8 hours per day on weekends plus on call.
- Radiologists = 8 per day or 9 FTEs.
- Technologists = 20 Techs per day weekdays and 6 Techs weekends (to cover call) = 23 Technical FTEs.

Table 10: Red Deer Model Results 2001-2006

Year	**2001**			**2006**			**2006**		
Scan Rate/1000	**24**	**30**	**36**	**39**	**48**	**58**	**48**	**60**	**72**
Total Scans	5861	7327	8792	10661	13121	15856	13121	16403	19683
Average Scans Per Day	22	27.5	33	40	49	59	49	61	74
Maximum Scans	24	30	36	44	54	65	54	68	81
Scan Hrs @ 1.8 Scans Per Hr	13.4	16.8	20.1	24.4	30	36.3	30	37.5	45
Minimum # MRI's	1	1	1	2	2	2	2	2	3
Shifts									
Weekdays	2	2	2	3	3	4	3	4	5
Weekends	1	1	1	1	1	1	1	1	1
Estimated Operating Costs @ $244.46 in $000's	1,433	1,791	2,149	2,606	3,207	3,876	3,207	4,009	4,811

MRI and manpower requirements at 24 scans/1000

- 1 MRI operating 16 hours per day M-F and on call on the weekend.
- Radiologists = 1.5 per day or 2 FTEs.
- Technologists = 1 Tech & 1 LPN per shift. 2.50 Technical FTEs and 2.50 LPN FTEs.

MRI and manpower requirements at 30 scans/1000

- 1 MRI operating 16 hours per day M-F and 1 shift on the weekend plus on call.
- Radiologists = 1.5 per day or 2 FTEs.
- Technologists = 1 Tech & 1 LPN per shift and add urgent and non-urgent volumes to a weekend shift. 2.50 Technical FTEs and 2.50 LPN FTEs.

Table 11: Calgary Model Results – 2001-2006

Year	**2001**			**2006**			**2006**		
Scan Rate/1000	**24**	**30**	**36**	**39**	**48**	**58**	**48**	**60**	**72**
Total Scans	27612	34515	41418	51721	63656	76919	63656	79571	95484
Average Scans Per Day	104	129	155	193	239	288	239	298	358
Maximum Scans	114	142	171	213	262	317	262	328	393
Scan Hrs @ 1.8 Scans Per Hr	63.1	78.9	94.7	118.3	145.6	175.9	145.6	182	218.3
Minimum # MRI's	4	5	6	7	9	10	9	11	13
Shifts									
Weekdays	7	9	11	13	17	20	17	21	25
Weekends	1	2	2	2	3	3	3	3	4
Estimated Operating Costs @ $244.46 in $000's	6,750	8,437	10,125	12,643	15,561	18,803	15,561	19,451	23,342

MRI and manpower requirements at 24 scans/1000

- 5 MRIs 2 of which operate 16 hours per day and 3 operate 8 hours per day. 1 MRI operates 16 hours on weekends plus on call.
- Radiologists = 6 per day or 7.0 FTEs.
- Technologists = 14 Techs per day weekdays and 6 Techs weekends (to cover call) = 16 Technical FTEs.

MRI and manpower requirements at 30 scans/1000

1. 5 MRIs 4 of which operate 16 hours per day and 1 operate 8 hours per day. 2 MRIs operate 8 hours on weekends plus on call.
- Radiologists = 6.5 per day or 7.0 FTEs.
- Technologists = 18 Techs per day weekdays and 6 Techs weekends (to cover call) = 21 Technical FTEs.

Table 12: Lethbridge Model Results 2001-2006

Year	**2001**			**2006**			**2006**		
Scan Rate/1000	**24**	**30**	**36**	**39**	**48**	**58**	**48**	**60**	**72**
Total Scans	3433	4291	5149	5784	7118	8602	7118	8899	10678
Average Scans Per Day	13	16	19	22	27	32	27	33	40
Maximum Scans	14	18	21	24	29	35	29	37	44
Scan Hrs @ 1.8 Scans Per Hr	7.8	9.8	11.8	13.2	16.3	19.7	16.3	20.3	24.4
Minimum # MRI's	1	1	1	1	1	1	1	1	2
Shifts Weekdays Weekends	 1 1	 1 1	 1 1	 2 1	 2 1	 2 1	 2 1	 2 1	 3 1
Estimated Operating Costs @ $244.46 in $000's	839	1,048	1,258	1,413	1,740	2,102	1,740	2,175	2,610

MRI and manpower requirements at 24 scans/1000

- 1 MRI operating 8 hours per day M-F and 1 shift on the weekend.
- Radiologists = .75 per day or 1 FTE (would require 2 trained MRI radiologists at a minimum).
- Technologists = 1 Tech & 1 LPN per day and add urgent and non-urgent volumes to a weekend shift. 1.25 Technical FTEs and 1.25 LPN FTEs

Table 13: Medicine Hat Model Results 2001-2006

Year	**2001**			**2006**			**2006**		
Scan Rate/1000	**24**	**30**	**36**	**39**	**48**	**58**	**48**	**60**	**72**
Total Scans	2341	2893	3472	4190	5157	6232	5157	6446	7736
Average Scans Per Day	9	11	13	16	19	23	19	24	29
Maximum Scans	10	12	14	17	21	26	21	27	32
Scan Hrs @ 1.8 Scans Per Hr	5.3	6.6	7.9	9.6	11.8	14.3	11.8	14.7	17.7
Minimum # MRI's	1	1	1	1	1	1	1	1	1
Shifts Weekdays Weekends	 1 1	 1 1	 1 1	 1 1	 1 1	 2 1	 1 1	 2 1	 2 1
Estimated Operating Costs @ $244.46 in $000's	572	707	848	1,024	1,260	1,523	1,260	1,575	1,891

MRI and manpower requirements at 24 scans/1000

- 1 MRI operating 8 hours per day M-F and on call on the weekend.
- Radiologists = .75 per day or 1 FTE (would require 2 trained MRI radiologists at a minimum).
- Technologists = 1 Tech & 1 LPN per day. 1.25 Technical FTEs and 1.25 LPN FTEs.

MRI and manpower requirements at 36 scans/1000

- 1 MRI operating 8 hours per day M-F and 1 shift on the weekend.
- Radiologists = .75 per day or 1 FTE (would require 2 trained MRI radiologists at a minimum).
- Technologists = 1 Tech & 1 LPN per day and add urgent and non-urgent volumes to a weekend shift. 1.25 Technical FTEs and 1.25 LPN FTEs.

Caveat

This report does not advance a conclusion on what an appropriate wait time standard should be for MRI services. What has been identified is that at a rate of 24 scans per 1,000 population waits of 24 hours for emergent, 30 days for urgent and 90 for non-urgent are possible. However, it is not clear what impact this will have on demand and wait times. It is expected that the work being completed by the Western Canada Wait List project may provide important insight into the management of wait times beyond 2001.

Conclusions:

1. The minimum recommended scan rate for 2001 of 24 scans per 1000 population is attainable at all MRI scan sites and scan sites should attempt to make progress to achieve the Canadian Association of Radiologists' recommended rate of 37.6 scans per 1000.
2. Higher scan rates are achievable with the MRIs that will be in place. Difficulty in achieving higher scan rates will be site and volume dependent. Manpower and operating dollars will be the limiting factors.
3. MRIs will be in six locations including Grande Prairie, Edmonton, Red Deer, Calgary, Lethbridge and Medicine Hat and Regional Health Authorities responsible for those locations will provide services to referring Regions. The Calgary Regional Health Authority and the Capital Health Authority will see significant increases in MRI volume due to the number of other regions referring to them and given the number of subspecialty programs offered in Calgary and Edmonton. Grande Prairie and Red Deer will also experience significant increases due to import volumes from adjacent regions.
4. The allocation of additional resources, inclusive of operational funds, must be considered for those regions providing MRI services if the minimum scan rate of 24/1000 or higher scan rates are to be realized. The base operational cost of a scan rate of 24 per 1,000 population in Alberta is estimated to be $17.8 million per year in 2001 dollars. The base operational cost of achieving a scan rate equivalent to the CAR rate is estimated to be $26.8 million per year. This cost includes professional fees, staff costs, contract maintenance and supplies. The total cost does not include any overhead allocations, the capital cost of equipment, the facility modification costs to house the equipment or the annual upgrade costs.

5. The length of time for non-urgent patients could be reduced to 60 calendar days from 90 days without any statistically significant deviation in waits or needed MRI capacity. The challenge will be to manage the impact of emergent patients on scheduled urgent and non-urgent patients. Emergent patients will "bump" scheduled patients who will then need to be accommodated within established wait periods.
6. The 2006 scan rates are between 39 -72 scans per 1,000 population. These targets should be viewed as only broad indicators of true demand. True demand for 2006 will be determined through the use of appropriateness criteria.
7. The amount of equipment will not be the "rate limiting" factor when improving access to MRI services in Alberta to a rate equivalent to the CAR recommendation. The availability of radiologists and technologists could be the "rate limiting" factor if investment in training and recruiting are not advanced. Funding MRI at recommended levels will attract new MRI radiologists to the province.
8. Based on a scan rate of 24 per 1000 population 19.5 radiologist FTEs will be required. As practical experience indicates that radiologists will support imaging services other than dedicated MRI responsibilities, this evidence suggests the demand for 19.5 radiologist FTEs could in fact be higher. Efforts to recruit and retain radiologists trained in MRI should be aggressively pursued.
9. The range of technologists required to support the 2001 minimum scan rate of 24 per 1,000 population is between 41.75 and 48 FTEs. This demand target is based upon a staffing model that contemplates a range of options including an LPN and technologist complement and the exclusive use of technologists to support MRI service provision. According to estimates for the SAIT/NAIT combined MRI training program, there are currently 15 technologists in training for MRI. It is critical to retain all graduates within Alberta and to increase the number of technologists trained to support increases in demand near and long term. In addition, efforts to recruit trained MRI technologists from other provinces and countries should be advanced.
10. There are alternative staffing models available to mitigate the impact of the technologist manpower shortages and these models should be evaluated. The options for evaluation include:
    - Option 1 – staff each MRI with two trained MRI technologists. The advantage of this option would be that the MRI would operate continuously through each 8-hour shift as staff breaks would be staggered.
    - Option 2 – staff each MRI with a single trained MRI technician and an LPN or other licensed staff member capable of giving injections and providing other clinical needs. This option would cause each MRI to be shut down for 1+ hours per shift, but would reduce the number of

MRI technologists required by 50% (scanner would shut down for breaks). The impact would be a loss of 2 scans per shift per scanner.

11. Facility and equipment productivity enhancements should be investigated wherever possible. One option includes enhancing productivity by placing two MRI machines together in centers where demand is high. Each facility would be staffed with three staff members versus four to minimize down time and maximize the staff ratio to machine.

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